INFERRING RELATIONSHIPS USING EPISODIC AND SEMANTIC INFORMATION

A Thesis

Presented to

the Faculty of the Department of Psychology

University of Houston

In Partial Fulfillment

of the Requirement for the Degree

Master of Arts

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by

Tammy M. Bourg

December, 1985

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Abstract

Adults' abilities to derive inferences requiring the integration of primarily episodic versus primarily semantic information were investigated. Eighty undergraduates viewed 1 of 4 edited versions of an animated television program that varied in terms of completeness of plot (complete vs. partial) and continuity of presentation (holistic vs. separated). Continuity of presentation had no effect on subjects' abilities to answer recall questions assessing episodic inferencing, semantic inferencing, and verbatim memory. Subjects in complete plot conditions performed better than subjects in partial plot conditions on all 3 question types. Subjects who viewed the complete plot versions showed no performance differences on the 3 types of questions. However, subjects who viewed the partial plot versions answered more episodic than semantic inference questions correctly. Also, their performance on the verbatim memory questions was better than on the inference questions. Results are discussed in terms of Tulving's (1983) hypothesis regarding inferential reasoning and episodic and semantic memory.

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INTRODUCTION

In 1972, Tulving proposed a distinction between two long-term information processing systems, episodic and semantic memory. Briefly, Tulving proposed that the episodic system is responsible for the storage and processing of autobiographical data, of personal experiences, and of particular events or episodes. The semantic system, on the other hand, stores and processes the individual's general knowledge of the world, independent of autobiographical instances. Tulving (1972) originally stated that his reference to episodic and semantic memory as two separate systems or stores did not necessarily reflect a belief that the two are functionally distinct. However, he and several others (Atkinson, Hermann, & Wescourt, 1974; Lockhart, Craik, & Jacoby, 1976; Tulving, 1976; Watkins and Tulving, 1975) later referred to the two as functionally distinct long-term memory systems. Furthermore, Tulving reformulated his distinction in 1983 proposing several additional hypotheses regarding differences between episodic and semantic memory and maintaining that the two are separate, functionally distinct systems.

Since Tulving originally proposed the distinction between episodic and semantic memory, there has been much controversy regarding the functional differences of the two. Most cognitive psychologists agree that episodic and semantic memory may indeed represent different types of information and that the distinction may have heuristic value. However, general consensus has not been reached regarding issues of whether different processes actually operate in the two "systems", whether episodic and semantic memory can operate independently of each other, and, thus, whether they are indeed two separate memory systems. Anderson and Ross (1980) accept a content distinction between episodic and semantic information, and Naus and Halasz (1979) argue for an episodic-semantic information continuum. However, these psychologists contend that both types of information are handled by the same memory system, not by two separate systems. The assertion of a unitary long-term memory system suggests that the same set of processes operate, though perhaps in varying degrees, with both types of information, or along the information-type continuum.

A demonstration that the same processes do

indeed function in a primarily episodic and a primarily semantic task would provide evidence against a functional distinction between episodic and semantic memory. The purpose of the present study was to illustrate that the processes of information integration and inferential reasoning operate across two or more discrete episodic events and in primarily semantic tasks. In the following sections, I will discuss 1) Tulving's (1972) original distinction between episodic and semantic memory, 2) Tulving's (1983) refined distinction, 3) the unitary viewpoint of long-term memory, and 4) relevant research regarding inferential reasoning and knowledge integration.

Episodic-Semantic Distinction

The Original Distinction.

According to Tulving's 1972 distinction, the semantic system consists of the individual's knowledge of the world, which includes knowledge of words and their meanings, concepts and their interrelations, and rules for manipulating such knowledge. Tulving (1972) posited that the semantic system is organized according to the

meaningful properties and interrelations of its items. When new information is entered into the system, it is interconnected with other items possessing similar properties. So, regardless of the temporal co-occurrence of different facts about a particular concept, these facts will be stored in an interconnected fashion if they are stored in semantic memory. In other words, new information being input into the semantic system is incorporated into an existing cognitive structure so that the system is concerned with memory for meaningful holistic units of information. Such organization allows for the integration and recombination of the stored information, which, in turn, permits the generation of logical inferences and generalizations. Therefore, the retrieval of information in the semantic system is not dependent upon actual input of directly perceived experiences, and retrieval involves active constructive processes (Brown, 1975a; Moeser, 1976; Tulving, 1972). In addition, based on this tightly organized structure, Tulving (1972) stated that information in the semantic system is relatively invulnerable to interference.

In contrast, the episodic system stores

personally experienced events or episodes which are encoded and subsequently organized as discrete units along a temporal continuum. Because episodic memories are temporally organized and autobiographical in that they consist of a record of our personal histories, Tulving (1972) further proposed that retrieval cues or questions should contain specific information regarding the time and place of the to-be-remembered event. Furthermore, the episodic memory system involves retrieval of actual input of directly perceived events, which may or may not be meaningful and which are presumed to be more vulnerable to interference than information in semantic memory. Since the act of retrieving information from either the episodic or semantic system is itself an event, the episodic system is in a constant state of change and, thus, information within the system is subject to change and forgetting due to interference (Tulving, 1972).

The Refined Distinction. In 1983, Tulving elaborated upon his 1972 distinction, which he described as being inchoate. In addition to arguing for differences between episodic and semantic memory he also acknowledged some commonalities between the

two. According to Tulving, both systems involve "... the acquisition, retention, and utilization of information and knowledge" (Tulving, 1983, p. 32). In addition, Tulving classified episodic and semantic memory as two types of propositional, as opposed to procedural, memory. Briefly, procedural memory refers to the specific cognitive and perceptual motor skills required to perform a task, and propositional memory refers to the individual's storehouse of knowledge (Kolers, 1975b; Scheffler, 1965; Tulving, 1983; Winograd, 1975). Classifying episodic and semantic memory under the same category of propositional memory reflects the presupposition that the two do share certain characteristics. According to Tulving (1983), these characteristics include

1) that questions regarding the veridicality of information in the episodic or semantic system are meaningful
2) that information in both types of propositional memory systems may be thought about and reflected upon introspectively
3) that communication of information in both episodic and semantic memory involve the use of a symbol system such as language
4) that information in episodic and semantic memory differ from procedural memory in that the acquisition of propositional knowledge does not necessarily require intensive practice and may be obtained from one perceptual experience or thought.

Despite these commonalities, Tulving (1983) stated that although the two are closely interacting

systems, episodic and semantic memory should be thought of as separate and functionally distinct. Two major categories of hypothesized differences proposed by Tulving (1983) include a) the different types of information stored and b) differences in operations functioning in episodic and semantic memory. Due to the number of hypothesized differences subsumed under each category, only the differences relevant to the present study will be discussed here. Also, it is important to remember that these differences are extensions of the previously discussed distinctions between episodic and semantic memory proposed in 1972.

a) Different Types of Information. Regarding differences in information, Tulving's 1983 characterization of episodic and semantic memory differs only slightly from the previously discussed 1972 distinction. Tulving's stance regarding the temporal organization of episodic memory and the conceptual, or meaningful, organization of semantic memory remained the same from 1972 to 1983. The notion of the personal referent of information in episodic memory also remained unchanged. In semantic memory, it is proposed that input information possesses referential relations to knowledge of some aspect of

the world, and not to the event from which the information was obtained. This was called cognitive reference in 1972 and universe reference in 1983.

Tulving (1972) stated that although perception and thought are the two sources of semantic memory input, it is the cognitive referents of input signals that are registered into the semantic system, and not the perceptible properties of inputs. In 1983, Tulving posited that the immediate source of semantic memory information is comprehension, arguing that the information must be comprehended and not just perceived before it can be related to existing semantic knowledge in any meaningful way. On the other hand, he stated that 'mere sensation' is sufficient for recording information in the episodic system.

As described above, Tulving (1983) claimed that episodic and semantic memory differ in terms of the immediate source of information recorded in each system. Although he did acknowledge that much of the information in both systems is derived from external events through the senses, he also stated that some of the information in both systems "... may be provided internally by thoughts, introspection, and

imagination, and other 'higher' mental processes" (Tulving, 1983, p. 36). It would seem that an internally provided unit of information would have to be derived through the integration of "internal", or stored, information. Otherwise, where would, for example, the thoughts or imaginations which may serve as internal sources come from? Even internally provided sources of episodic or semantic information would have to have a source from which they are derived. They cannot be created from nothing. The logical source of these thoughts, introspections, imaginations, and other 'higher' mental processes would seem to be information extracted from memories of previous experiences (in other words, previously stored information). Following that, because Tulving (1983) also stated that "both the episodic and semantic systems register only change ..." (Tulving, 1983, p. 37), the result of utilizing internally provided sources of information would have to be new information constructed from existing information. This new information would be constructed through the process of integrating previously stored information.

If the argument described above is the case, and if, as Tulving (1983) stated, some information in

both systems may be provided internally, it would seem that there would have to be meaningful connections between information stored in episodic memory and between information stored in semantic memory. How could one access and integrate pieces of information unless there are meaningful connections between them? Tulving's (1972, 1983) claim that information stored in the episodic system is merely temporally, and not meaningfully, organized is inconsistent with this argument. These arguments also seem inconsistent with the reasoning behind Tulving's statement concerning the differences in the inferential capabilities of episodic and semantic memory, which will be discussed in the next subsection. Given these arguments, it seems that it would be more parsimonious to conceptualize episodic and semantic information as organized in a meaningful fashion within one memory system (e.g., Anderson and Ross, 1980; Naus and Halasz, 1979).

b) Differences in Operations. Arguments similar to the ones discussed above may be used when examining Tulving's hypotheses regarding differences in some of the functional operations of the two systems, namely the operations of inferential capability,

vulnerability, and retrieval consequences. Tulving (1983) defined inferential capability as the ability to derive information in addition to that which is explicitly provided by an input. He proposed that this is achieved by adding stored information to input information and treating the integration of this information as the original. Tulving (1972) initially said that inferential reasoning is an important process of the semantic system, but that the episodic system lacks inferential capability. In 1983, however, he modified his position stating that the episodic system is relatively limited regarding inferential capabilities. He argued that the tight, conceptual organization of knowledge in the semantic system, as opposed to the loose, temporal organization of the episodic system, affords the semantic system with richer inferential capability than the episodic system.

One aspect of Tulving's (1983) hypothesis regarding the restricted inferential capability of the episodic system is that knowledge about the contents of a particular event can be derived only from the stored representation of that event, and not from other events stored in the system. Similarly, Moeser

(1976) explained that unlike the semantic system, there are no meaningful connections between the memory traces formed in the episodic system which would allow knowledge to be inferred from one event or memory trace to another. In his 1983 reformulation, Tulving conceded that episodes do contain some semantic properties, and that inferences regarding the semantic contents within independent episodes can be made. He also stated that as events become part of a regular routine, knowledge of the routine is stored in semantic memory. Hence, inferences can be made regarding particular events which make up a routine, but these inferences are based on the semantic knowledge of the regular routine. Tulving (1983) also asserted that information stored within the episodic system is reproductive in nature whereas information stored within the semantic system is reconstructive, although episodic information is more vulnerable to modification and forgetting.

In 1983, Tulving further explained the rationale behind his statement that information stored in the episodic system is more vulnerable to change, modification, and forgetting than information stored in the semantic system. He discussed three reasons

behind his hypothesis regarding the greater vulnerability of the episodic system. The first reason has to do with the inclusion of primarily overlearned information in the semantic system versus the inclusion of information based upon single episodes in the episodic system. The second reason is that the hypothesized loose organization of the episodic system in contrast to the tight organization of the semantic system may contribute to the greater vulnerability of the episodic system. The third reason is that because a single unit of episodic information may be composed of a rich combination of cognitive elements, it may more easily lend itself to modification, recoding, and erasure.

Tulving's (1983) suggestion that the loose organization of the episodic system contributes to its vulnerability to modification and to its limited inferential capability, and that the tight, meaningful organization of the semantic system is responsible for its relatively smaller vulnerability and richer inferential caplability seems contradictory. How is it that stored information is modified? It would seem that to modify a particular unit of information, something would have to be taken away from or added to

that informational unit. Modification through the addition of information would logically require the integration of two or more pieces of stored information or the integration of stored information and new information. If episodic modification can occur through the integration of two or more pieces of stored information, it would seem that the connections between episodic information would have to be meaningful.

However, whether or not stored episodic information can be integrated is an empirical question. Because Tulving (1972, 1983) proposed no meaningful connections between episodic information, his theory would predict that two pieces of stored episodic information cannot be integrated. However, I have previously argued that Tulving's (1983) discussion of internally provided sources of episodic and semantic memory information seems to require integration of stored information and meaningful connections for both episodic and semantic information. Moeser (1976) claimed to have found evidence against the ability to integrate discretely stored episodic information. However, the argument that discrete episodic information can be integrated

and used to derive inferences will be developed on the basis of other theories of memory, related empirical research, and a critique of Moeser's work in later sections of this paper.

Modification through the integration of stored information and new information seems very similar to Tulving's (1983) definition of inferential capability. Recall that inferential capability was defined as the ability to integrate new information with stored information resulting in the generation of new, additional information, or an inference. Thus, if information in the episodic system can be modified through the addition of information, then saying that the episodic system is very vulnerable to modification seems to be functionally equivalent to saying that it is capable of inferential reasoning.

As a matter of fact, Tulving (1983) proposed that changes in episodic memory traces result from recoding. Recoding refers to the integration of information within an interpolated event with an episodic trace containing similar information thereby resulting in a new trace. According to this definition, recoding is modification through the integration of stored information and new

information. Tulving (1983) stated that recoding is also a retrieval consequence of the episodic system in that answering a question about an episode results in changing or recoding its trace. Although Tulving's conceptualization of recoding implies change, he acknowledged that this implication may be contested. He acknowledged the possibilty that recoding may result in additional memory traces and that original traces may continue to exist. This, too, is an empirical question. Regardless of whether recoding causes the formation of an additional memory trace or change in an existing trace, it seems that recoding and inferential reasoning require the same operations and thus are two names for the same process. For both recoding and inferential reasoning, information from two different encoding situations is combined and the end result is new information available during retrieval.

Conclusion. Although Tulving (1972, 1983) argued that episodic and semantic memory are functionally distinct, close examination of some of his hypothesized differences reveals inconsistencies. It appears that there are more similarities between the two proposed systems that Tulving articulated. In

some cases, Tulving described the same processes as operating in both systems, but under the rubric of different processes. If operations, or processes, function similarly with both episodic and semantic information, then it would seem that the two are not functionally distinct. Arguments have been presented in this section suggesting that episodic and semantic memory are not functionally distinct, and that it is more parsimonious to view episodic and semantic information as meaningfully organized in a unitary long-term memory system.

Unitary Viewpoint of Long-Term Memory

Because much information contains both episodic and semantic properties, some argue that viewing the two as dichotomous systems is unsatisfactory, and that it is more parsimonious to think of the two as comprising a single long-term memory system (Craik, 1979; Naus and Halasz, 1979). For example, scripts for different events (i.e., generalized event structures which allow us to have expectations regarding the sequence of actions of a particular situation) possess properties charactaeristic of episodic and semantic

memory. Concerning the episodic properties, scripts are temporally organized and involve knowledge about personally experienced events. However, scripts are semantic in the sense that they appear to be represented as general knowledge structures which are consistent over time and across individuals (Nelson, 1979; Schank and Abelson, 1977). Thus, Craik (1979) stated that scripts are examples of knowledge which appear to lie somewhere between purely episodic and semantic knowledge. Because it is difficult to categorize such knowledge as either semantic or episodic, it is also difficult to view the two as separate systems. Craik (1979) believed that conceptualizing episodic and semantic memory as the end points of a continuum, as described by Naus and Halasz (1979), is one solution to this problem.

Naus and Halasz (1979) argued against a dichotomous long-term memory system and proposed the alternative notion of an episodic-semantic continuum within a unitary system. Naus and Halasz explained that, according to the levels-of-processing framework proposed by Lockhart et.al. (1976), new information is initially processed semantically, or is semantically encoded, and is then entered into the

episodic system. Then, for learning to occur according to this dichotomous viewpoint, a different set of processes is responsible for transferring information from the episodic system into the semantic system thereby causing changes in the semantic system. However, an adequate and parsimonious set of such processes has not been proposed. It seems more parsimonious to regard long-term memory as a unitary memory system with a single set of processes responsible for both episodic and semantic traces, as proposed by Naus and Halasz.

Naus's and Halasz's (1979) unitary viewpoint suggests that a single set of processes is responsible for storing and retrtieving information, and that the depth at which information is encoded determines where the information lies along the episodic-semantic continuum. Information that is encoded at a deep semantic level lies at the semantic end of the continuum. In contrast, information which is not processed very elaborately and which retains contextual properties lies near the episodic end of the continuum. Information that is processed at an intermediate level contains both semantic and episodic properties and, thus, is located somewhere along the

continuum. The exact location of such information depends upon both the degree of semantic and episodic properties and the depth of processing. For the purposes of the present paper, the most important point concerning the unitary system is that it calls for a single set of processes which handles both episodic and semantic traces.

Anderson's (1976, 1983) spreading activation theory (ACT) also views episodic and semantic information as part of one long-term memory system. According to this theory, all information, whether episodic, semantic, or a combination of the two, is stored as an interconnecting network of propositions. Anderson and Ross (1980) recognized that different traces may possess different characteristics as Tulving (1972) suggested. However, in agreement with Naus and Halasz (1979), they argued that particular memory traces may also possess both episodic and semantic properties. Anderson and Ross (1980) maintained that "... there is no functional distinction between semantic and episodic information in terms of storage, retention, or retrieval. It is all one big memory." (Anderson and Ross, 1980, p. 442). It seems, then, that if episodic and semantic

information are represented in the same memory system, the same set of processes would be responsible for both types of information and for all other information along the continuum.

Empirical Research On Knowledge Integration and Inferential Reasoning

Having its historical roots in the constructivist view of memory (Bartlett, 1932; Cofer, 1973; diSibio, 1982) many of the research findings regarding integration and inferencing are interpreted as illustrating that inputs are integrated with prior knowledge in memory and stored in such a manner that exact traces of the original inputs do not exist. That is, research in this area has been used to support the idea that memory is constructive and reconstructive in nature, and not veridical. Also, some of the methods, such as sentence recognition tasks, used in assessing inferencing and integration assume that the inferences themselves are in some way stored in memory (e.g., Bransford and Franks, 1971). However, it may be that in some cases traces for the original inputs do exist, and that the actual

inferences are not stored, but are derived during retrieval (see Garnham, 1982). Although this particular controversy is beyond the scope of the present paper, a few points regarding the matter and its relation to the present study should be noted.

The position that subjects spontaneously integrate related information and generate inferences at input suggests that related information learned independently of each other will be stored in a meaningful manner and inferences may be derived using this information. By virtue of the characteristics of the memory system, such a position does not seem to allow for Tulving's (1983) hypothesis regarding inferential reasoning, nor for an episodic-semantic functional distinction. In contrast, even if subjects may sometimes store two related events independent of each other, a demonstration that subjects may derive inferences by integrating information from the two events would also refute Tulving's (1983) hypothesis that the inferential capability of the episodic system is limited. That is, such a demonstration would indicate that in contrast to Tulving's (19s83) hypothesis, deriving knowledge about an episodic event is not necessarily restricted to the stored

representation of that event.

Research in the Semantic Integration Tradition. Initial research in this area has been done using the sentence integration paradigm. In one set of experiments, Bransford and Franks (1971) presented adults with sentences containing one, two, or three elemental propositions from each of four idea sets. Each idea set consisted of four separate elements. Although subjects were not presented sentences containing all four elements of an idea set, they reported recognizing test sentences containing all four elements with the highest degree of confidence.

These data demonstrate that adults integrated information from semantically related sentences, and falsely recognized sentences that were not actually heard, but which were meaningfully consistent with sentences previously presented. Bransford and Franks (1971) concluded that each sentence is not stored veridically in memory, but that subjects abstract the meaning of the idea set to form an integrated representation, or cognitive structure, and that is what is stored in memory. The findings and interpretation of the Bransford and Franks (1971) experiments are consistent with those of other studies

(e.g., Barclay, 1973; Jarvella, 1971; Sachs, 1967).

Barclay (1973) as well as others (Bransford and Franks, 1971; Bransford, Barclay, and Franks, 1972) argued that subjects extract information from individual sentences and integrate that information to form representations which contain more information than the sentences themselves. This position suggests that relationships not explicitly stated during acquisition are somehow stored. The use of recognition test sentences also reflects this viewpoint. Experiments in the semantic integration tradition suggest that subjects "go beyond the information given" and infer and integrate relationships from separate, but semantically related stimulus information.

Deriving Inferences Using Prior Knowledge. In addition to studies illustrating that adult subjects can infer relations among elements contained in separate stimulus sentences, studies demonstrating that adults can make inferences by integrating stimulus information with prior knowledge have also been conducted (e.g., Bower, Black, & Turner, 1979; Johnson, Bransford, & Solomon, 1973; Sulin and Dooling, 1974). Sulin and Dooling (1974) presented

adults with two short biographical passages. After 1-week, subjects who thought the stories were about famous characters falsely recognized thematically related sentences which were not included in the stimulus stories. This suggests that adults integrated the stories with prior knowledge of the famous character and inferred that the thematically related sentences were part of the stories.

In another thematic intrusion study, Bower, Black, and Turner (1979, exp. 3 & 4) presented adults with either 1, 2, or 3 stories based on the same scripts. Results indicated that subjects in the two and three script version condition made more theme-related, or script-based, inferences than subjects in the one script version condition.

Anderson (1983) interpreted the Bower et.al. (1979) results by postulating that as the number of stories presented to subjects increased, so did the number of opportunities to rehearse and strengthen what he called the elaborative schemata. According to Anderson, the elaborative schemata is the mechanism by which elaborative processes such as inferencing occurs. The elaborative schemata are stored in long-term memory, and may be composed of specific

events and/or more general representations of events which are thematically, or meaningfully related. If increasing the number of thematically related stories presented to subjects strengthens the elaborative schemata, then the knowledge necessary for making thematically-related inferences becomes more available, and thus, more inferences are made. Anderson (1983) also stated that actual thematically-related stories presented earlier could also serve as elaborative schemata.

It seems that one may think of the different stories as different episodic events. If so, Anderson's (1983) statement that earlier stories may be used in generating inferences, does not seem consistent with Tulving's S(1983) position on inferencing and episodic and semantic memory. In addition it seems that, according to Anderson's explanation, specific related stories would be stored in a meaningful manner, becoming part of an elaborative schematic memory structure. This, too, would not support a functional distinction between episodic and semantic memory.

Inferencing and Integration In More Complex "Real-World-Simulated" Events. Loftus and her

colleagues (Loftus 1975, 1979a, 1979b, Loftus, Miller, and Burns, 1978; Loftus and Palmer, 1974) have conducted a series of experiments concerning subjects' memories for complex, real world, events. In general, these studies indicate that subsequent interrogative sessions containing misleading information can alter subjects' recollections of originally observed events. Loftus and Palmer (1974) argued that subjects store a representation of the originally observed event in memory, and questions regarding the event supply new information which may be integrated with the original representation. They also argued that the integration process results in a modified representation.

Shaughnessy and Mand (1982), however, have provided some evidence indicating that when misleading information is presented subsequent to an event, perhaps both the original information regarding the event and the misleading information is in memory. Regardless, Loftus's findings provide examples of the integration of information within two discrete, but related, events or episodes (the originally observed event and the questioning session) producing new information which was not actually perceived. Whether

we call this recoding, inferencing, or some type of interference, the bottom line is that information is integrated from two separate events and new information is generated. Thus, these results do not seem consistent with Tulving's opinion that knowledge regarding a certain episodic event can be obtained only from the stored representation of that event.

In another study regarding complex events, Collins, Wellman, Keniston, & Westby (1978) presented a televised dramatic narrative to second, fifth, and eighth graders. Memory for both the explicit and the implicit content of the program improved with age. Because answers to the inferencing questions could be derived only by combining information from two or more scenes of the televised narrative, one may be inclined to say that the results of this study illustrated the process of inferential reasoning across two or more episodic events.

However, the study conducted by Collins et.al. (1978) was not designed to address the question of inferential reasoning across separate episodic events, and, thus, is somewhat limited for making conclusions regarding this question. The Collins et.al. (1978) study does suggest, however, that it is possible to

derive inferences from smaller events which are part of a larger event. A more powerful way to test whether relationships can be inferred across discrete episodes would be to temporally separate the events. Temporal separation would force subjects to encode the events as separate episodes.

Collins (1973) did conduct a study which investigated the effect of temporal separation between scenes of motivation, aggression, and consequences on third, sixth, and tenth graders' responses to a self-aggression-potential measure. Results indicated that the self-aggression-potential scores from base-line to postexposure was greater for third graders in the separation condition than for third graders in the no separation condition. It may be that the third graders in the separation condition could not integrate information across the three separated scenes. Temporal separation had no effect on sixth and tenth graders' scores implying that they were able to integrate information across the separated scenes.

If sixth and tenth graders are capable of integrating information across discretely presented scenes or events, they should also be able to make

inferences using information from discrete events. And, of course, adults should also be capable of this. Because the dependent measure in Collins' (1973) study was questions about subjects' own aggression and not inferencing questions about the content of the separated scenes, the study does not explicitly demonstrate, nor was it Collins' intention to explicitly demonstrate, that inferencing can occur across separate episodic events. However, the findings do imply that it may be possible for sixth and tenth graders, and presumably adults, to integrate episodic information and, thus, to infer relationships across separate events regarding information presented in those events.

Empirical Attempts to Assess Inferencing Across Episodes. Moeser (1976, exp. 1) specifically addressed the question regarding inferencing in episodic memory. She randomly assigned subjects from each of grades K, 2, 6, and 9 to one of three encoding conditions, either the holistic sentences condition, the separately presented ordered propositions condition, or the separately presented random propositions condition. Subjects in the holistic condition showed the best performance on the

inferencing test items, and subjects in the random propositions condition obtained the lowest inferencing scores.

Moeser (1976) argued that independently presented items were encoded and stored as discrete events. She also claimed that both ordered and random propositions subjects' poorer performance on inference questions than on memory questions suggested that the premises themselves were available in memory. However, because the premises were encoded as discrete events, they could not be used to derive inferences. She stated that subjects in the holistic condition were able to derive inferences because both the premises and the inferential relationships were stored in memory. Moeser concluded that the results supported Tulving's (1972) contention that there are no meaningful connections between discrete events encoded into the episodic system, even if those events are semantically related.

Although the results were in accordance with her predictions, there are some questions as to whether Moeser's (1976) results actually support her conclusions. Three criticisms will be presented. First, the relatively lower proportion of correctly

chosen inferences for the random propositions group may have been due to its disordered, confusing nature and to the use of NONCASE test items, and not to an inability to derive inferences when related information is encoded or stored separately. NONCASE test items were false inferences and false premises consisting of elements from two or more different complex ideas presented at acquisition. Moeser later argued that due to retrieval interference (see Moeser, 1982), the presentation of similar NONCASES during the test phase confuse subjects in nonsequential, or random, conditions and cause them to falsely recognize some NONCASES as part of the acquisition corpus.

Why, then, did the nonsequential presentation of the random propositions condition (Moeser, 1976, exp. 1) not have a debilitating effect on performance on memory questions, which also contained some NONCASES? Perhaps the ceiling effect obtained on the memory questions could have obscured any possible differences among conditions. Therefore, it may be possible that memory performance would be affected by presentation condition. If so, subjects in the random propositions condition would become confused and incorrectly choose false (noncase) memory questions.

Interestingly, in another series of studies, Moeser (1977) did find differences in memory as well as inferencing performance between sequential and nonsequential encoding conditions.

Secondly, Moeser (1976) used a very narrow definition of an episode--sentences and separately presented propositions of complex ideas. Perhaps richer, more ecologically valid episodes such as the audiovisually presented complex events used by Collins (Collins 1974; Collins et.al., 1978) would induce more inferencing, even if the episodes are separated.

Thirdly, Moeser (1976) studied logical inferences, which are inferences based on formally specified rules which are independent of the context of the premises. To derive such inferences one must rearrange the premises syllogistically (Paris, 1978). Therefore, logical inferences seem to require deliberate processing and short-term memory working space. Thus, perhaps subjects in Moeser's (1976) random propositions condition obtained the lowest inferencing scores because more deliberate processing effort and time was required to rearrange the disordered premises in order to derive the logical inferences.

The Present Study. In the present experiment, subjects' abilities to make inferences which are more automatic in nature was studied. Paris (1978) called these pragmatic inferences. According to Paris (1978), pragmatic inferences are derived from prior experiences and add new knowledge such as intentions, feelings, thoughts, implied consequences, presuppositions, and inferred instruments of actions to situations. This is the type of inference investigated by Collins and his colleagues (Collins, 1974; Collins et.al., 1978). Recall that Collins's studies suggested that individuals in the sixth grade and beyond should be able to make inferences using information from discretely encoded events, although they did not directly address this issue.

The main purpose of the present study was to demonstrate that adults are capable of inferring relationships across discretely encoded rich, audiovisually presented episodic events, and that primarily episodic as well as primarily semantic information can be utilized in deriving inferences. The present study was conducted to lay the groundwork for future studies investigating this issue developmentally.

Two types of pragmatic inferences were assessed, semantic inferences and episodic inferences. Semantic inferences required the integration of information presented in a stimulus event with previously stored semantic knowledge. Episodic inferences required the integration of primarily episodic information from separately presented stimulus events.

It is important to realize that in order to make a statement regarding inferencing and episodic and semantic memory, dependent measures which reflect the difference between episodic and semantic inferences should be used. It is not enough to just manipulate presentation of materials as Moeser (1976, 1977, 1982) did. Perhaps it is easier to derive inferences from holistically presented ideas than from independently presented ideas as Moeser found (Moeser, exp. 1). But it may be that the performance differences between holistic and independent presentations is the same for both episodic and semantic inferences. That is, it may be the case that performance on both episodic and semantic inferencing questions are greater in a holistic presentation condition than in an independent presentation

condition.

Recall that Moeser (1976, 1977, 1982) studied logical inferences and did not distinguish between episodic and semantic inferences. Those logical inferences were slightly similar to pragmatic episodic inferences in that they did require the integration of two pieces of stimulus information. However, none of the inferences that Moeser's subjects were asked to make bear even a vague resemblance to the semantic inferences described previously. Therefore, because her study was not designed to do so, her results can not be used to make a strong statement regarding the relative inferential capability of episodic and semantic information. In the present study, performance on episodic and semantic inferencing questions was assessed in holistic and separated stimulus presentations to test the following hypothesis. When the necessary stimulus information is available, performance on both episodic and semantic inferencing questions should be affected in the same way by holistic and separated presentation conditions.

To insure that episodic inferencing questions do require information from two separate stimulus

events, some subjects viewed a partial plot of the stimulus program in which some of the events presumably necessary for making episodic inferences were missing. Remaining subjects viewed the complete plot containing all of the scenes of the edited program. Thus, subjects in the complete plot condition should perform better than subjects in the partial plot conditions on the episodic inferencing questions.

METHOD

Subjects

Subjects were 80 undergraduates enrolled in psychology courses at the University of Houston. Subjects were randomly assigned to conditions.

Design

The study was a 2 (completeness of plot) x 2 (presentation) x 20 (subjects per cell) x 2 (question

type) mixed factorial design.

Materials

Stimuli. An edited version of an animated television program was used. The particular story was unfamiliar to the subjects. The program was edited to a) include only plot-essential scenes as identified by adult judges, and b) assure reasonable continuity. The program was approximately 13 minutes in length, and was divided into five scenes, or segments (i.e., a beginning scene, three middle scenes, and a concluding scene). Each segment was approximately two and one-half minutes long. Appendix A includes a complete description of the plot of the story and instructions given to subjects.

Test Questionnaire. After viewing the program, subjects completed a questionnaire corresponding to the program just presented. The questionnaire consisted of three types of recall questions: 1) episodic inference questions, 2) semantic inference questions, and 3) verbatim memory questions. There were 11 episodic inference questions, 11 semantic

inference questions, and 13 verbatim memory questions. Five of the episodic and five of the semantic inference questions required information excluded in the partial plot conditions.

The episodic inference questions were designed to assess subjects' abilities to make inferences across discrete episodic events. Answers to the episodic inference questions were not explicitly stated at any one point in the program. Episodic inference questions required subjects to integrate primarily episodic information from separate scenes, or segments, and infer the answer to the question asked.

The second type of question involved semantic inferences. Semantic inference questions required the integration of stimulus information encoded as a single event with previously stored semantic knowledge. The most important difference between the episodic and semantic inference questions was that the episodic inference questions required subjects to make inferences by integrating primarily episodic information from stimulus scenes which were encoded as separate events. The semantic inference questions, on the other hand, did not require this.

The third type of questions was verbatim memory questions. These assessed memory for information explicitly stated in the program. Included were verbatim memory questions assessing memory for the premise episodes from which inferences were made.

So that responses to the memory questions would not influence responses to the inference questions, the episodic and semantic questions were presented first, in a randomized order. The same random order was used for each subject.

After answering all questions, subjects were asked to rate on a 5-point scale their respective presentation conditions in terms of cohesiveness of presentation and cohesiveness of storage. They were also asked to rate how easy it was to integrate information necessary for answering questions. Finally, subjects were asked to rate on a 5-point scale how familiar were the characters of the program, and to state whether they had ever seen the stimulus program before. Data from subjects who had seen the stimulus program before were not used.

Subjects read their own questions and wrote their answers. Appendix B includes the questions

comprising the questionnaire.

Procedure

The videotapes were viewed on a 19-inch color television monitor. Subjects were tested in small groups of 1-7 people. The subjects were instructed to pay close attention to the television program because they would be asked questions about it later. Program scenes were presented in sequential, as opposed to nonsequential, order in all conditions to prevent obtaining a possible interference effect (see Moeser, 1977, 1982). During the interruption periods of the separated conditions, subjects were asked to work on a Mental Rotation Test, an intervening task completely unrelated to the stimulus materials and requiring a substantial amount of the subjects' attention. It was believed that such an intervening task would break the narrative flow and possibly encourage independent storage (if independent storage is possible). Twenty subjects were randomly assigned to one of the between groups conditions described below.

Complete Plot-Separated Presentation Condition:

Subjects in the complete plot-separated presentation condition viewed all five scenes with temporal separations between each scene. Each temporal separation period was two and one-half minutes long, the approximate length of each scene. During the separation periods, subjects completed items from a mental rotation test adapted by Vandenberg (1971). After viewing the program subjects completed the questionnaire described above.

Complete Plot-Holistic Presentation Condition: Subjects in this condition viewed the complete version of the program with no temporal separations between the scenes. After viewing the holistic version, subjects completed the questionnaire.

Partial Plot-Separated Presentation Condition: Subjects in this condition viewed only the three middle scenes (scenes 2, 3, and 4) of the program. Two and one-half minute temporal separations were inserted between the scenes. Subjects in this condition also worked on the mental rotation test during the separation intervals. The questionnaire was completed after viewing the program.

Partial Plot-Holistic Presentation Condition:

Subjects in this condition viewed the partial version of the program as one single event. The remaining procedures for this condition was identical to those in the complete plot-holistic presentation condition.

Dependent Measures

The major dependent measures were the proportion of correct episodic inference questions, proportion of correct semantic inference questions, and proportion of correct verbatim memory questions. Each answer was scored on a 0-3 point scale. A score of 3 was given for each completely correct answer and a score of 0 for each completely incorrect answer. A score of two was given for each answer which contained some information regarding the crucial component of the correct answer, but had some missing details. An answer received a score of 1 if it contained information remotely related to the correct answer, but excluded the crucial component and adequate details. The scores for each question were determined by consensus of three adult judges.

Subjects' ratings for each question regarding

familiarity of characters and cohesiveness of presentaions were used as dependent variables in separate analyses.

RESULTS

Recall Data

Comparison of Episodic and Semantic Inferencing Performance. The mean scores for the episodic inference questions and the semantic inference questions for each condition are presented in Table 1.

Insert Table 1 about here

A three-way MANOVA (completeness of plot x presentation x question type) with the question type factor repeated was conducted for the scores on the episodic inference questions and on the semantic inference questions. The analysis revealed a significant main effect of completeness of plot, $F(1,76)=153.06$, $MSE=30.41$, $p < .001$, a significant main effect of question type, $F(1,76)=5.07$, $MSE=9.34$, $p < .05$, and a significant completeness of plot x

question type interaction, $F(1,76)=4.39$, $MSE=9.34$, $p < .05$. No differences between holistic and separated presentations were found.

A least significant difference test indicated that there was no difference between episodic and semantic inferencing performance for subjects who viewed the complete plot of the program. However, subjects in the partial plot conditions performed better on the episodic inferencing questions (15.57) than on the semantic inferencing questions (13.47), LSD, $p < .05$. Also, Tukey tests indicated significant differences between scores of episodic inference questions in complete plot conditions (25.35) and scores on episodic inference questions in partial plot (15.57) conditions, $p < .05$, and between scores on semantic inference questions in complete (25.27) versus partial plot conditions (13.47), $p < .05$. These findings are illustrated in Figure 1.

Insert Figure 1 about here

Comparison of Episodic Inferencing, Semantic Inferencing, and Verbatim Memory Performance. Because the number of verbatim memory questions was not equal to the number of episodic inference questions and the

number of semantic inference questions, subjects' scores for each question type were converted to proportions. Table 2 contains the mean scores for episodic inferencing, semantic inferencing, and verbatim memory questions for each condition in proportional format.

Insert Table 2 about here

A test for homogeneity ofvariance was conducted and was not significant. The proportional scores were entered into a three-way MANOVA, completeness of plot(2) x presentation (2) x question type (3), with the question type factor repeated. The MANOVA revealed a significant main effect for completeness of plot, $F(1,76)=100.60$, $MSE=.04$, $p < .001$, a significant main effect for question type, $F(2,75)=32.27$, $MSE=.008$, $p < .001$, and a significant completeness of plot x question type interaction, $F(2,75)=44.05$, $MSE=.008$, $p < .001$. These findings are illustrated in Figure 2.

Insert Figure 2 about here

To further examine the Completeness of Plot x Question Type interaction, tests of the simple main effects of each question type and of each level of

plot were conducted. Table 3 contains the mean proportion episodic inference scores for subjects in the complete and partial plot conditions. The test of the simple effect of Plot within Episodic Inference Questions was significant, $F(1,78)=100.79$, $MSE=.017$, $p < .001$, indicating higher performance on episodic inference questions in complete plot conditions (.77) than in partial plot conditions (.47).

Insert Table 3 about here

As Table 4 shows, the significant simple main effect of Plot within Semantic Inference Questions revealed higher semantic inferencing scores for subjects in complete plot (.77) conditions than in partial plot conditions (.41), $F(1,78)=139.46$, $MSE=1.462$, $p < .001$.

Insert Table 4 about here

Table 5 contains the means entered into the analysis of the simple main effect of Plot within Verbatim Memory Questions. Subjects in complete plot conditions obtained higher verbatim memory scores (.75) than subjects in partial plot conditions (.64), $F(1,78)=13.20$, $MSE=1.397$, $p < .001$.

Insert Table 5 about here

The simple main effects of Plot at each level of Question Type are illustrated in Figure 3.

Insert Figure 3 about here

As Table 6 shows, the analysis of the Question Type within Complete Plot simple main effect indicated no differences between the proportional episodic inference, semantic inference, and verbatim memory scores for subjects in the complete plot conditions.

Insert Table 6 about here

However, the analysis of the Question Type within Partial Plot simple effect revealed a significant question type effect, $F(2,38)=77.36$, $MSE=.007$, $p<.001$. Table 7 contains the mean scores for each question type for the partial plot conditions.

Insert Table 7 about here

Using the Bonferroni Method, simple pairwise comparisons were conducted on the following pairs of means to determine the source of this question type effect: 1) mean proportion episodic inference scores versus mean proportion semantic inference scores, $t=3.7$, $p < .001$, 2) mean proportion episodic inference scores versus mean proportion verbatim memory scores,

$t = -9.02$, $p < .001$, 3) mean proportion semantic inference scores versus mean proportion verbatim memory scores, $t = -12.41$, $p < .001$. The pairwise comparisons indicated that for the partial plot conditions, mean performance on episodic inference questions (.47) was greater that that on semantic inference questions (.41). Verbatim memory performance (.64) was greater than episodic inferencing performance (.47). And, partial plot subjects also scored higher on verbatim memory questions (.64) than on semantic inference questions (.41).

To insure that it was necessary to view the stimulus program to correctly answer the questions, 20 undergraduate students who did not view the program were asked to complete the questionnaire. The mean percentage scores for this control group were as follows: episodic inference questions = .75%, semantic inference questions = 2.4%, verbatim memory questions = 2.5%. These low percentages indicate that the questions could not be adequately answered by relying solely on general knowledge. Exposure to the stimulus program was necessary.

Questions Regarding Familiarity of Characters and Cohesiveness of Presentation

Two-way analyses of variance, completeness of plot (2) x presentation (2), were conducted on the ratings for each question (excluding question #1) in the Familiarity-Cohesiveness portion of the questionnaire (see Appendix B). In question number 1, subjects were asked if they had ever seen the stimulus program prior to the experiment. Only the data from subjects who had not seen the program before were used in the study. Two of the remaining five questions revealed significant findings, question number 2 and question number 3. For question number 2, subjects were asked to rate, on a scale from 1-5 (1=not at all familiar, 5=very familiar), how familiar were they with the characters in the stimulus program. A significant completeness of plot x presentation interaction was obtained, $F(1,69)=7.52$, $MSE=1.74$, $p<.01$. Ideally, all subjects should be equally familiar with the program characters prior to the experiment. Question number 2 was supposed to assess whether this was indeed the case. However, it was discovered that some subjects were not certain if they were being asked how familiar were they with the characters

before or after the experiment. Thus, it is not certain how many subjects did not ask for clarification and interpreted the question to mean familiarity with the characters after the experiment. Due to the poor wording of this question, the data obtained are inconsistent and the analysis meaningless. Future studies of this sort should ask a question regarding familiarity with characters before the experiment, and familiarity with characters after the experiment. One thing of interest, though, is that the mean familiarity of characters rating for the entire sample was 2.20, a relatively low rating.

For question number 3, subjects were asked to rate on a scale from 1-5 (1=not at all cohesive, 5=very cohesive) how cohesively did they feel was the presentation of the program. A significant presentation effect, $F(1,69)=4.32$, $MSE=.96$, $p < .05$ indicated that subjects who viewed the program as one continuous presentation felt the program was presented more cohesively (3.12) than subjects who viewed the program as five separated segments (2.62).

DISCUSSION

The primary finding of this study is that when adults

are presented with the requisite premise information, they are equally capable of deriving inferences requiring primarily episodic information and of deriving inferences requiring primarily semantic information. This supports the hypothesis that adults can use both episodic and semantic information to derive inferences. This finding is contrary to Tulving's (1972, 1983) hypotheses regarding inferential reasoning and episodic and semantic memory. Tulving (1972) stated that the episodic system is incapable of inferential reasoning whereas the semantic system is capable of inferential reasoning. In 1983 he revised his claim hypothesizing that the episodic system possesses limited inferential capabilities and that the semantic system possesses rich inferential capabilities. To support either of Tulving's contentions regarding inferential reasoning, the adult subjects in this study would have had to have correctly answered more semantic inference questions than episodic inference questions. However, that was not the case. The adults who viewed the complete program plot performed equally well on the episodic and semantic inference questions.

Tulving's inferential reasoning hypothesis is

one of many concerning his functional distinction between episodic and semantic memory. The findings discussed in the previous paragraph suggest that the process of inferential reasoning operates, or functions, similarily with episodic and semantic information when adults have available to them all of the information necessary for making the inferences. According to Tulving (1983), one of the three major categories of hypothesized differences between episodic and semantic memory is the category of differences in operations functioning in each. If episodic and semantic information are indeed stored in two functionally distinct memory systems, then the operations, or processes, handling episodic versus semantic information should differ. However, these findings suggest that the process of inferential reasoning does not differ with episodic and semantic information. If it is found that other processes in addition to inferential reasoning function similarly with episodic and semantic information, then such findings would indicate that episodic and semantic memory are not functionally distinct. Future empirical work is necessary to determine if other processes such as deliberate versus automatic access, retrieval mechanisms, and developmental sequence, for

example, (see Tulving, 1983, p. 35 for a list) operate similarly or differently with episodic and semantic information.

Although subjects in the partial plot conditions did differ in their performance on episodic and semantic inference questions, the difference was not in the direction predicted by Tulving's hypothesis. Rather, subjects who were presented with only some of the information required for making inferences made more correct episodic than semantic inferences. This is a surprising finding considering that there were an equal number of episodic and semantic inference questions requiring information not presented in the program viewed by these subjects. Intuitively, one would think that when premise information is unavailable, subjects would resort to their general semantic knowledge and correctly derive more semantic than episodic inferences.

However, note that in this task both types of inference questions had to contain some premise information so that the subjects would know what was being asked in each question. For example, the semantic inference question, "How does Alyson feel when her mom says she shouldn't attend the town

meeting?" contains the premise information that Alyson's mother said Alyson should not attend the town meeting. Subjects in the partial plot conditions did not view this premise information. However, they did receive this information in the question, although the premise information present in the questions were not as richly presented as in the audiovisual program. Likewise, the episodic inference questions also contained some premise information not presented to subjects in the partial plot conditions. Why, then, were subjects better able to integrate the premise information contained within an episodic inference question with the other necessary "bit" of episodic information than they were to integrate the premise information contained within a semantic inference question with a "bit" of general semantic knowledge to derive the appropriate inferences? Perhaps the subjects may not have had an appropriate knowledge base from which to obtain information necessary for making the semantic inferences.

If subjects are unfamiliar with the content or subject matter of the program or the characters of the program, then they may not have the appropriate semantic knowledge necessary for making the semantic

inferences. It is unlikely that the adult subjects in this study had a problem comprehending the subject matter of this children's animated program. However, the characters of this program were unique to this program. Therefore, because only adults who had never seen the program before were included in the study, it can be assumed that subjects did not have a knowledge base regarding typical traits and behaviors of the characters. Additional support for subjects' unfamiliarity with the program characters is provided by the low ratings of familiarity.

Now consider the following semantic inference question again:

> How does Alyson feel when her mom says she shouldn't attend the town meeting?

One may think that one could answer this question by using the knowledge that little girls in general usually feel dissappointed, or angry, or in some way negative when they are told they should not do something. However, general semantic knowledge regarding the behaviors and feelings of little girls in certain situations may not be sufficient. Perhaps knowledge about Alyson's feelings and behaviors in particular types of situations is required.

This is not to say that speicfic prior knowledge regarding program characters is required for making semantic inferences when subjects actually view characters' reactions and behaviors in particular situations. As the performance of subjects in the complete plot conditions indicates, when subjects actually view characters in particular situations, they can integrate that information with their knowledge of how and why people in certain situations feel and behave in certain ways to derive a semantic inference. Further, they could make a semantic inference just as easily as they could integrate two pieces of episodic information actually viewed in the program to derive an episodic inference. It is when subjects do not actually view all the details regarding a character in a particular situation that prior knowledge of the character may aid them in making a semantic inference regarding the character in a particular situation.

Another possible explanation for the differential episodic-semantic inferencing performance in the partial plot conditions involves the presence of premise information in the questions. Four out of the five episodic inference questions requiring

information not present in the partial program plot contained some of the unpresented information in the questions. Although all five of the corresponding semantic inference questions contained some unpresented information, there may be a quantitative and/or a qualitative difference in the clues provided for the four episodic inference questions versus the clues provided for the five semantic inference questions. For example, if an episodic inference question requires the integration of two pieces of information, one of which is presented in the partial program plot and one of which at least a part of the information is presented only in the question, then the subject has two clues available to help derive the inference. However, subjects are presented with only one clue, especially subjects without an appropriate knowledge base, when asked to answer a similar type of semantic inference question. Further, this one clue is presented in the question making it less rich and detailed. Schmidt and Paris (1983) found that children's performance on inference questions regarding narrative stories improved not only with age, but also with the number of clues provided.

It is important to realize that this does not

mean that subjects do not need to be presented with both pieces of episodic information in the program to perform optimally on the episodic inference questions. Remember that subjects in the complete plot conditions performed significantly better on the episodic inference questions than subjects in the partial plot conditions. This pattern was also found for semantic inference questions. The explanation regarding clues is proposed only as a possible reason for the relatively greater episodic inference performance in the partial plot conditions. To determine the reasons for this finding, future studies should investigate the effects of 1) familiarity with characters and subject matter, 2) the presence of unpresented stimulus information in the questions, and 3) the types of clues given in questions containing unpresented premise information.

Another important finding emerging from the partial plot conditions was that verbatim memory performance was greater than both episodic and semantic inference performance. A likely explanation is that there were proportionately less verbatim memory questions requiring unpresented information (23% verbatim memory questions, 45% episodic inference

questions, and 45% semantic inference questions). On the other hand, because there were no differences between verbatim memory, episodic inference, and semantic inference questions for subjects in the complete plot conditions, it seems that those who viewed all the necessary information were able to use that information to answer all three types of questions. Studies of information integration and inferential reasoning in the constructive memory tradition have shown that adults and children falsely recognize correct inferences and integrations more often than they recognize sentences which were actually presented to them (i.e., verbatim sentences) (e.g., Barclay, 1973; Bransford and Franks, 1971; Paris and Upton, 1976). Such findings have led to the constructivist view that integrations are somehow stored in memory, not veridical information. It is believed, however, that these recall data of subjects in the complete plot conditions suggest that some verbatim information is likely to be stored as well.

The findings of the present are also contrary to Moeser's (1976) conclusions regarding inferential reasoning and episodic memory. By comparing the effect of holistic versus separated presentations of

sentences on the inference performance of children from 5-14 years of age, Moeser (1976) concluded that independently presented items are encoded and stored as discrete events (in episodic memory) which cannot be used to derive inferences. However, the present study indicates that adults can integrate information presented in separated, discrete events just as they can integrate information presented in one holistic event to derive inferences.

The disparity between Moeser's (1976) findings and those of the present study may be due to several methodological differences between the two. As noted in the introduction, Moeser (1976) used randomly presented propositions which may have led to confusion in one of her separated presentation conditions. In the present study, the separated program segments were presented in proper, sequential order. Other differences between the two studies include 1) the types of inferences studied, 2) the use of recognition versus recall dependent measures, 3) the types of episodes used, and 4) the developmental level of the subjects. Recall that Moeser (1976) did not differentiate between episodic and semantic inferences. Moeser (1976) studied logical inferences,

which are closer in nature to the episodic inferences of the present study. However, if one considers only the epsiodic inferences, there were still no presentation effects in the present study. Perhaps the recall measure used in the present study allowed for more elaborative, reconstructive processing on the part of the subjects. The use of richer, audiovisually presented episodes, as opposed to the use of individual sentences as individual episodes, may have also increased the probability of reconstructive processing and inferential reasoning. The developmental level of the subjects may also be an important factor here. It may be that there are developmental differences in the ability to derive inferences from discrete episodic events. After all, developmental differences in inferential reasoning within singly presented "events" have been found (e.g., Paris and Upton, 1976). Future studies should investigate the development of the ability to derive inferences from discrete episodic events, and should compare the development of inferential reasoning using episodic and semantic information.

In summary, the present study indicates that adults are equally proficient at deriving inferences

requiring either episodic or semantic information when all of the necessary premises are available to them. The data also indicate that adults can integrate information across discretely presented episodic events and use that information to derive inferences. Interestingly, when adults are not presented with all the necessary premise information, they can correctly derive more episodic than semantic inferences. The reasons for the relatively greater episodic inference performance when partial information is given remain to be investigated. The findings of the present study are contrary to Tulving's (1983) inferential reasoning hypothesis and to Moeser's (1976) conclusions regarding inferential reasoning and episodic memory. In addition, because adults are able to make inferences requiring the integration of primarily episodic information, meaningful connections between episodic traces also seem necessary. This suggestion is also in contrast to Tulving's (1972, 1983) characterization of episodic memory traces. The findings of the present study and the future studies suggested in this paper will help us to better understand the nature and development of inferential reasoning with episodic and semantic information, and its implications for a theory of long-term memory.

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Appendix A

Scene 1: The program begins with a little girl's father informing her that strange things have been happening. He tells her that overnight the crops were ruined, the hens have stopped laying, and the cows have stopped giving milk. There will be a town meeting at their house that night to discuss the matter. Alyson, the little girl, asks if she and her cat, Winston, can attend. However, her mother says she does not think there is much a little girl and a cat can do. In response, Alyson tells Winston they will go to the treehouse to see if the two of them can figure out a solution. When Alyson and Winston are walking in the woods toward the treehouse, they see something and go back to the house to tell her mother. She tells her mother that she saw a big ball of light up in the trees, and her mother says it is time for Alyson and her imagination to go to bed.

Before going to bed, however, she sits at the foot of the stairs (apparently listening to the adults at the meeting). She then realizes that the problem is more serious than she thought because even the

grown-ups are scared. She then yawns loudly and tells Winston they had better get going before her mother returns.

Scene 2: Once in bed, Alyson is awoken by a green, evil-looking alien at her window. The alien accidentally knocks over her music box which is near the window. When the alien hears the music, he covers his ears and closes his eyes. Alyson then runs over and hits him with her teddy bear knocking him out of the window. She and Winston then crawl out of the window to search for the alien for she believes he knows about the changes that have occurred.

Instead of finding the evil-looking alien, however, they come upon a friendly one who is playing a flute near his spaceship behind the barn. Alyson learns that this alien's name is Twyler and he is from the planet Wobbly. He is on earth is because he is searching for something called an orb, which spread magic across the land with a light that protected the Wobblies and their planet. Twyler explains that one day, the evil Mergatoids arrived on Wobbly and stole the orb because it was an enemy of evil and they sought to spread misery throughout the universe. Without the orb, Wobbly is growing darker and sadder

each day and the people are dying.

Twyler further explains that a battle was fought between the Wobblies and Mergatoids, and all but one Mergaroid ship escaped back to their own dimension. The ship carrying the orb remained because the magic of the orb prevented it from returning to its dimension. The Wobblies were able to cripple the ship and free the indestructable orb, which fell to earth where it is no longer under their control and is bringing sorrow. Twyler says their only hope is to find the orb before the Mergatoids do and bring it back to Wobbly. Alyson then tells Twyler that she and Winston have seen the orb, and Twyler asks Alyson to take him to it.

Scene 3: Alyson, Winston, Twyler, and his three-man troop are then walking in the woods and find that the Mergatiods are surrounding the treehouse. They must figure out a way to get the Mergatoids away from the treehouse. Twyler comes up with a plan and sends the troops to their ship to await his signal. He then asks for a volunteer for a scouting mission to locate the Mergatoid craft. Winston volunteers and spots the ship. Twyler, Alyson, and Winston go to the Mergatoid ship where Twyler switches some wires

explaining that once the ship flies, it will be zapped back to its own dimension. Alyson asks how will they get the Mergatoids to take off, and Twyler's reply is "You'll see, but first we must recover the orb".

They then leave the Mergatoid ship and return to the woods, hiding behind some bushes near the treehouse. Because they cannot get to the orb with the Mergatoids around, they have to somehow frighten them away. Alyson has an idea and tells Twyler to play the most beautiful song he knows with his flute. Upon hearing the song, the Mergatoids scream, hold their ears, close their eyes, and fall out of the treehouse. Alyson and Winston then do various things such as trip them and drop a beehive over the head of one to detain them.

Scene 4: In this scene, the Mergatoids discover that the orb is gone. Alyson, Winston, and Twyler are undercover behind the bushes. Twyler plays something on his flute, cups his hand around his ear, hears a response, then sees the Wobbly ship in the air. The Mergatoids then see the Wobbly ship, too. One of the Mergatoids orders the others to their ship, thinking the Wobbly ship contains the orb. The Mergatoid ship chases the Wobbly ship, but is soon zapped away. The

Wobbly ship then picks up the orb and lands near Alyson, Winston, and Twyler.

Scene 5: The next morning, Alyson awakens, looks out her window, and runs out to the porch where her parents are marveling over the miraculous changes that have occurred overnight. Her mother says they should be thankful and her father says that maybe there's a little magic left in the world after all. Alyson then plays a short tune on the flute and winks at Winston. There is then a shot of the family on the porch, which gradually zooms out to show the house and fertile green grounds.

Instructions to Subjects:

Initial Instructions: You're going to watch a videotape, and you'll have to pay very close attention to it because you'll be asked to answer some questions about it later. All of your answers will be completely anonymous. You won't have to put your name on the answer sheet. The only time you'll have to sign your name to anything is when you sign the

informed consent form. (Hand out informed consent.) Read the informed consent form. If you have any questions, just ask me, then sign the form. (After subjects sign informed consent, take them up.) Okay, now pay close attention to the TV. (Play videotape.)

Instructions for Separation Intervals (separated conditions only):

At the end of a scene: (Hand out mental rotation task.) Okay, what I'd like you to do now is read the instructions and start working on this.

At the end of the 2 1/2 minute interval: Okay, stop, turn your papers face down, and watch the TV.

Appendix B

Instructions

Please answer the following questions as completely as possible. Answer the questions in the order in which they're presented. Don't skip any and don't go back to any. Take your time.

Episodic Inference Questions:

1. What did Alyson see the first time she and Winston went to the treehouse?

(requires the integration of information from scenes 1 & 2, scenes 1 & 3).

Answer: the orb

2. How does Alyson know that the Mergatoids can be frightened away if Twyler plays the most beautiful song he knows?

(scenes 2 & 3)

Answer: Because she remembers that the Mergatoid at her bedroom window didn't like the music he heard when he dropped her music box--he held his ears, etc. and she was able to hit him and he fled away

3. Where did the Mergatoid ship disappear to when it was chasing the Wobbly ship?

(scenes 3 & 4)

Answer: It was zapped back to its own dimension (or to its own space)

4. What do Twyler's troops do when they hear Twyler's signal?

(scenes 3 & 4)

Answer: They launch the ship (so that the Mergatoids will think they have the orb and go after them--need to get Mergatoids to their ship so they'll be zapped back to their own dimension)

5. When Alyson's parents were on the porch talking about the changes that occurred overnight, what changes were they referring to?

(scenes 1 & 5)

Answer: changes from the drought-like atmosphere to "normal" beautiful earth

6. What caused the crops to die?

(scenes 1 & 2)

Answer: the orb)

7. What consequences did Twyler's success at recovering the orb have for the earth?

(scenes 4 & 5)

Answer: It made things on earth nice and normal again (crops came back to life, etc.)

8. Why did Alyson wink at Winston after her father said "... maybe there's a little magic left in the world after all"?

(all scenes)

Answer: She knew all about the orb which caused the bad things to happen--and she helped Twyler regain the orb, remove it from earth (which made everything beautiful again)

9. Where is Twyler going after he, Alyson, and Winston say their good-byes?

(scenes 4 & 2)

Answer: home; Wobbly

10. Was Alyson's mother correct when she said she didn't think there was much a little girl and a cat could do to help the town's plight? Why or why not?

(all scenes)

Answer: no--Alyson and Winston are the ones who helped Twyler regain the orb, which in turn helped the town's plight and returned the earth back to normal

11. Why did Alyson think that her parents wouldn't believe the incident involving the alien at her bedroom window if she told them about it?

(scenes 1 & 2)

Answer: because they didn't believe her when she said she saw something at the treehouse

<u>Semantic Inference Questions</u>:

1. How do Alyson and Winston feel when Twyler leaves?

(scene 4)

Answer: sad

2. When they are at the dinner table, are the changes that Alyson's father is describing good or bad?

(scene 1)

Answer: bad

3. Why does Twyler have to return the orb to his planet?

(scene 2)

Answer: The orb protected his planet. Since it was stolen, his planet and people are dying. Therefore, he has to return the orb to save his planet and people, stop them from dying, make them happy again, and so the orb can once again protect the planet. Also, because the orb is no longer under the Wobblies' control on earth, returning the orb to Wobbly will bring things back to normal on earth.

4. Why does Twyler give Alyson his flute?

(scene4)

Answer: because he wants her to have something to remember him by (he likes her and wants her to remember him)

5. When Alyson and Winston were sitting on the stairway after Alyson's mother told her to go to bed and Alyson yawned, why did Alyson then tell Winston they'd better go to bed?

(scene 1)

Answer: The yawn was loud--mom may hear and may become angry with Alyson if she finds out she disobeyed

6. Why did Alyson sit on the stairs instead of go to bed when her mother told her to?

(scene 1)

Answer because she wanted to hear what the grown-ups would say at the meeting

7. What is Alyson's father's occupation?

(scene 1 or perhaps even from scene 2 or scene 5)

Answer: farmer

8. How do Alyson's parents feel when they are standing

on the porch looking at the land?

(scene 5)

Answer: happy; pleasantly surprised; relieved

9. How does Alyson feel when her mom says she shouldn't attend the town meeting?

(scene 1)

Answer: dissappointed; left out

10. Why was Alyson surprised to see Twyler behind the barn?

(scene 2)

Answer: She was looking for the other alien--her expectations were violated; another acceptable answer: Twyler is also an alien and one doesn't usually expect to see any alien behind one's barn

11. Why was the Mergatoid ship chasing the Wobbly ship?

(scene 4)

Answer: They thought it was carrying the orb

Verbatim Memory Questions:

1. What happened when the Mergatoid knocked over the music box?

(scene 2)

(necessary for episodic inference question #2)

Answer: He held his ears, closed his eyes (didn't like it; annoyed him or frightened him). Alyson hit him with teddy bear and he fled away.

2. Where did Alyson and Winston go right after dinner?

(scene 1)

(related to episodic inference question #1)

Answer: to the treehouse

3. Where is Twyler from?

(scene 2)

Answer: Wobbly

4. What did Twyler do when he was in the Mergatoid ship?

(scene 3)

(necessary for episodic inference question #3)

Answer: he tampered with the controls so that the Mergatoids would be zapped back to their own dimension when they take off in their ship

5. Why did the Mergatoids steal the orb in the first place?

(scene 2)

Answer: because the orb was an enemy of evil

6. What has happened to Twyler's people since the orb has been stolen?

(scene 2)

(necessary for semantic inference question #4)

7. Who saw the orb and knew where it was?

(scene 2)

Answer: Alyson

8. Who volunteered for Twyler's scouting mission?

(scene 3)

Answer: Winston

9. What did Twyler give Winston before leaving?

(scene 4)

Answer: A medal

10.What did Alyson's mother say when Alyson tried telling her about what she saw at the treehouse?

(scene 1)

(related to episodic inference question #11 and to semantic inference question #6)

11.What did the Mergatoids do when Twyler played his flute?

(scene 3)

(related to epsiodic inference question #2)

Answer: held ears, rocked, fell out of treehouse

12.When the Mergatoids discovered that the orb was missing, who did they think had the orb?

(scene 4)

(necessary for semantic inference question #1)

Answer: Wobblies

13.What did Alyson's father tell Alyson when they were at the dinner table?

(scene 1)

(necessary for episodic inference questions #5, 6, 8, 10, and semantic inference question #2, and perhaps #7)

Answer: he told her about the strange things that have been happening--crops dying, cows stopped giving milk, hens stopped laying--everything's in a muddle

Questions About Familiarity and Cohesiveness:

1. Have you ever seen the program about Alyson before today?
2. In general, how familiar are you with the characters in the story about Alyson?

1	2	3	4	5
not at all familiar	somewhat familiar	moderately familiar	familiar	very familiar

3. How cohesive do you feel was the presentation of the about Alyson?

1	2	3	4	5
not at all cohesive	somewhat cohesive	moderately cohesive	cohesive	very cohesive

4. How cohesively do you feel the scenes comprising the

program about Alyson was represented in your memory?

1	2	3	4	5
not at all cohesive	somewhat cohesive	moderately cohesive	cohesive	very cohesive

5. How easy was it for you to integrate the information necessary for answering questions about the story of Alyson?

1	2	3	4	5
not at all easy	somewhat easy	moderately easy	easy	very easy

6. How do you think the scenes comprising the program about Alyson were represented in your memory?

   a) as separate, independent units

   b) combined into one integrated unit

   c) other (if you choose this response, please try to explain your choice)

Table 1

Mean Episodic and Semantic Inference Scores

		Question Type			
		Episodic Inference		Semantic Inference	
Condition	n	M	SD	M	SD
Complete Plot					
Separated Pres.	20	25.95	4.95	25.15	5.15
Holistic Pres.	20	24.75	3.78	25.40	4.06
$\bar{X}$		25.35		25.27	
Partial Plot					
Separated Pres.	20	15.70	4.96	14.15	5.16
Holistic Pres.	20	15.45	3.68	12.80	3.52
$\bar{X}$		15.57		13.47	

Table 2

Mean Proportion Episodic Inference, Semantic Inference, and Verbatim Memory Scores

		Question Type					
		Ep. Inf.		Sem. Inf.		Verbatim	
Condition	n	M	SD	M	SD	M	SD
Complete Plot							
Separated Pres.	20	.79	.15	.76	.15	.76	.16
Holistic Pres.	20	.75	.11	.77	.12	.74	.13
$\bar{X}$		.77		.77		.75	
Partial Plot							
Separated Pres.	20	.47	.15	.43	.16	.65	.11
Holistic Pres.	20	.47	.11	.38	.11	.63	.13
$\bar{X}$		.47		.41		.64	

Table 3

Mean Proportion Episodic Inference Scores as a Function of Plot

		Episodic Inference	
Plot	n	M	SD
Complete	40	.77	.13
Partial	40	.47	.13

Table 4

Mean Proportion Semantic Inference Scores as a Function of Plot

		Semantic Inference	
Plot	n	M	SD
Complete	40	.77	.14
Partial	40	.41	.14

Table 5

Mean Proportion Verbatim Memory Scores as a Function of Plot

		Verbatim Memory	
Plot	n	M	SD
Complete	40	.75	.15
Partial	40	.64	.12

Table 6

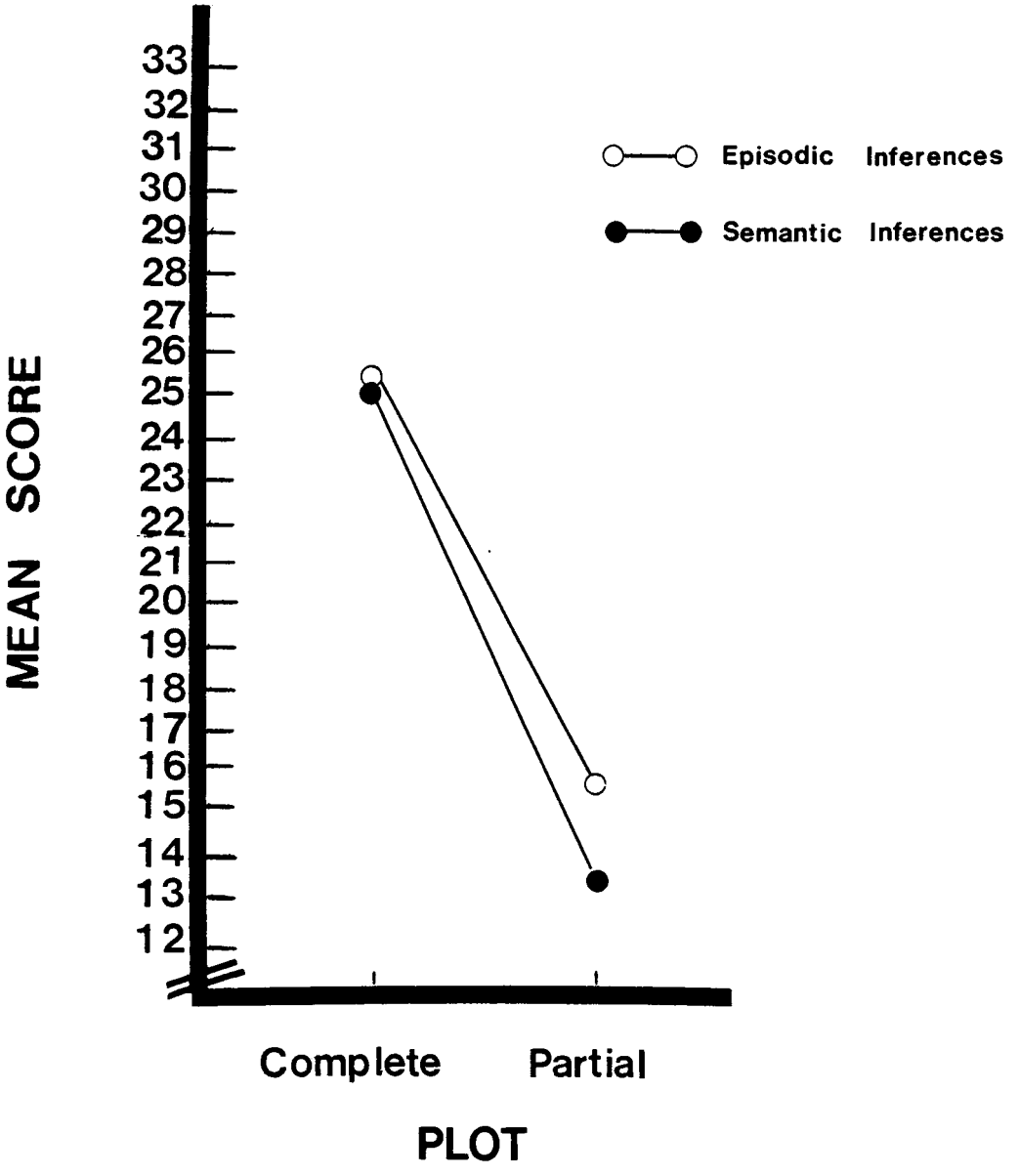
Mean Proportion Episodic Inference, Semantic Inference, and Verbatim Memory Scores for Complete PLot Conditions

Question Type	M	SD
Episodic Inference	.77	.13
Semantic Inference	.77	.14
Verbatim Memory	.75	.15

Table 7

Mean Proportion Episodic Inference, Semantic Inference, Verbatim Memory Scores for Partial PLot Conditions

Question Type	M	SD
Episodic Inference	.47	.13
Semantic Inference	.41	.14
Verbatim Memory	.64	.12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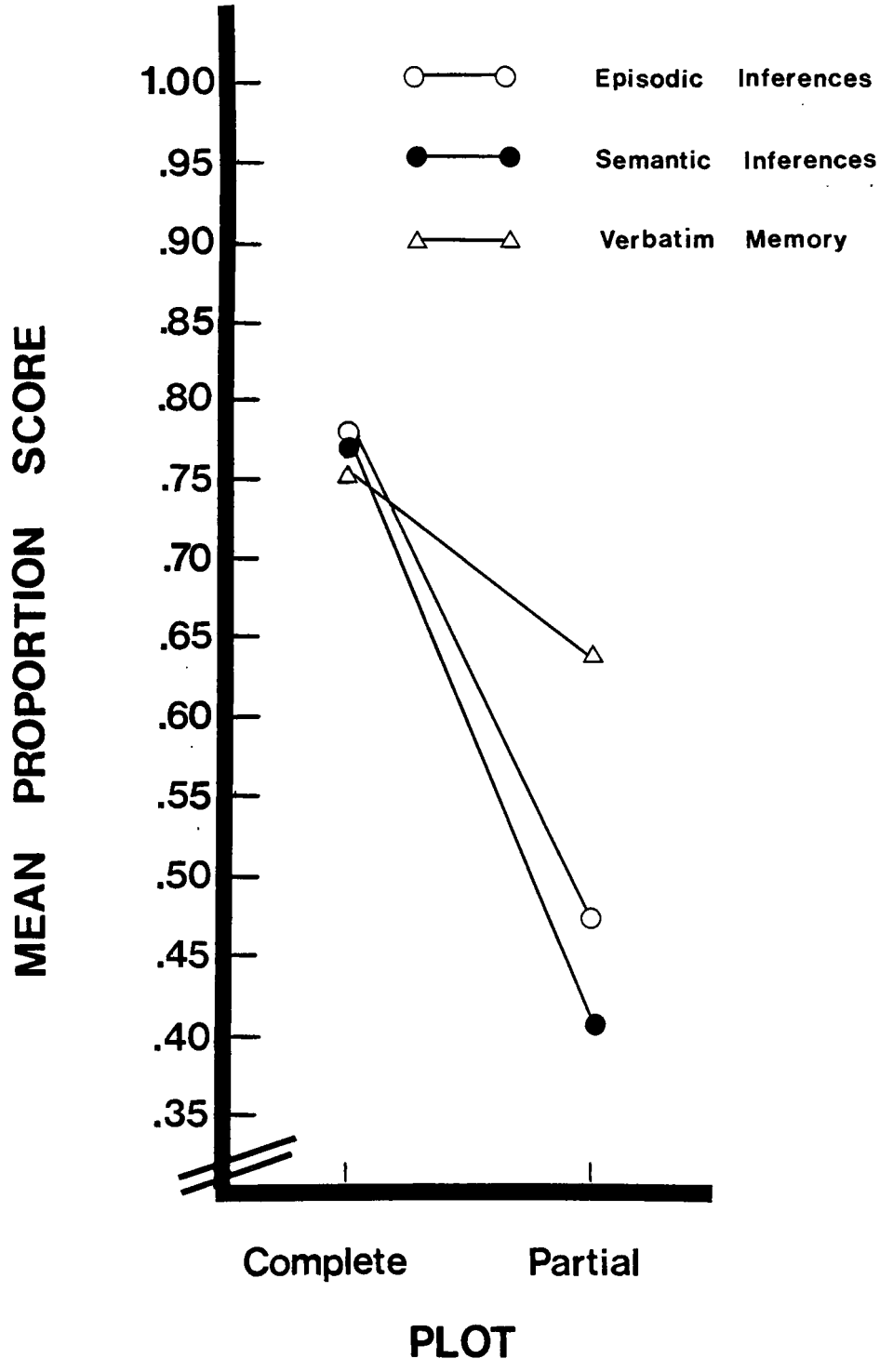
12
Episodic Inferences
Semantic Inferences
Complete
Partial
PLOT

Figure 1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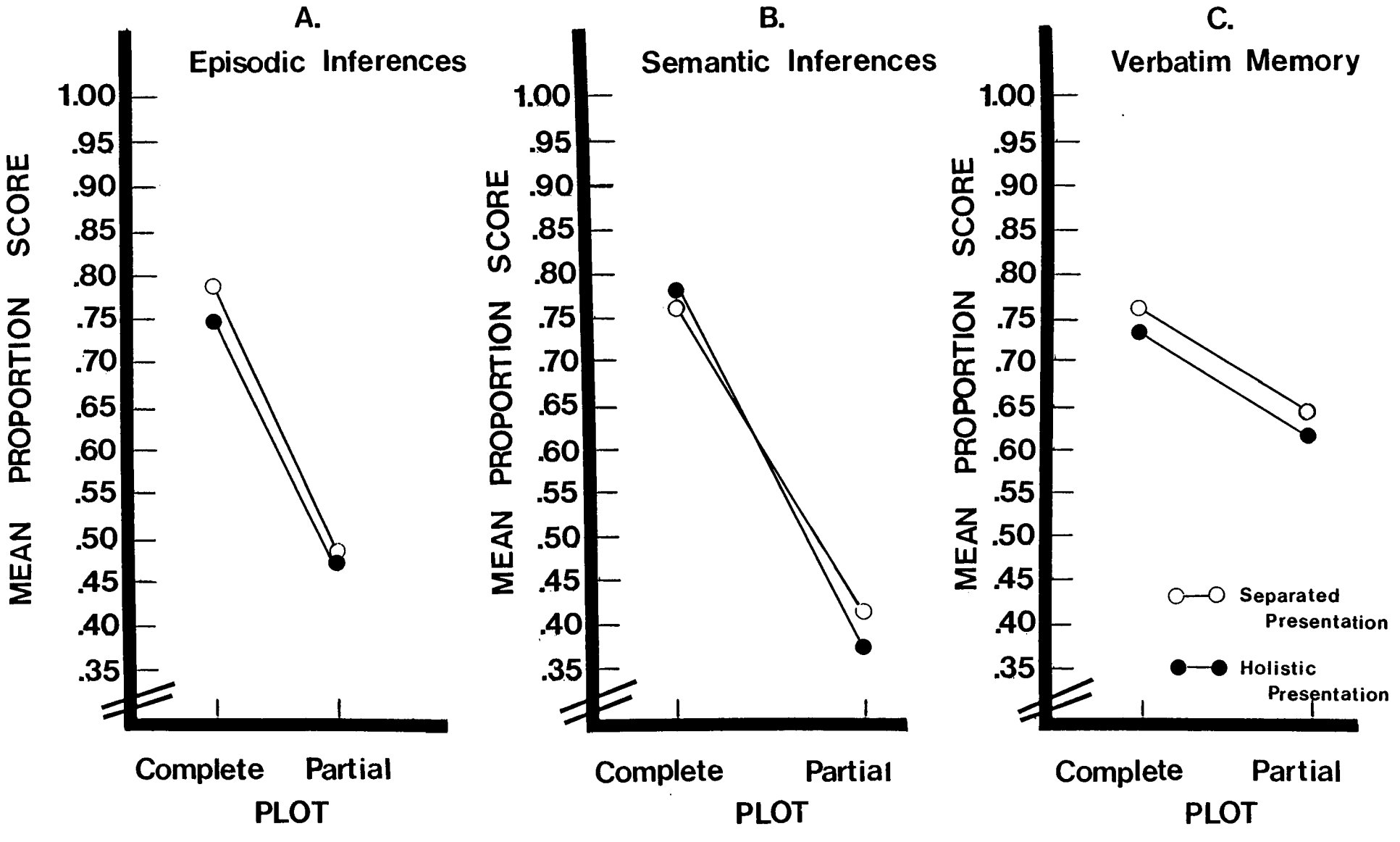
MEAN PROPORTION SCORE
Episodic Inferences
Semantic Inferences
Verbatim Memory
Complete
Partial
PLOT

Figure 2


A.
Episodic Inferences
B.
Semantic Inferences
C.
Verbatim Memory
MEAN PROPORTION SCORE
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.50
.45
.40
.35
Complete
Partial
PLOT
Separated Presentation
Holistic Presentation

Figure 3

FIGURE CAPTIONS

Figure 1. Performance on episodic and semantic inference questions for complete and partial plots.

Figure 2. Performance on episodic inference, semantic inference, and verbatim memory questions for complete and partial plots.

Figure 3. A. Performance on episodic inference questions for all 4 conditions: complete plot-separated presentation, complete plot-holistic presentation, partial plot-separated presentation, partial plot-holistic presentation.

B. Performance on semantic inference questions for all 4 conditions.

C. Performance on verbatim memory questions for all 4 conditions.